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Design and Development of an AC/DC Mechanical Jack Lifter

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ABSTRACT: The study was focused on the design and development of the AC/DC Mechanical Jack Lifter. This project development research tried to achieve the following objectives: (1. To develop a mechanism in mechanical toggle jack lifter using AC/DC to be more efficient, stress free, saves time and a reliable way to achieve lifting of the load; 2. Evaluate the acceptability of the developed device in terms of *design and construction*, *functionality*, *durability*, *and safety*; and 3. To determine the efficiency of the mechanical toggle jack lifter and manual jack in terms of: 3.1. Thread deformation test (*maximum displacement of jack*, *lifting time for electric jack* and *lifting time for manual jack*); and 3.2. Maximum load carrying test (*weight kg* and *displacement of jack mm*). The five-point Likert's scale was used to determine the descriptive meaning of the indicators of the variables used. In addition, Weighted Average Mean (WAM) was used to interpret data gathered. The Analysis of Variance (ANOVA) was also used to determine the significant difference between the evaluations of the respondents.

Evaluation result shows that the acceptability of the project obtained an Overall Weighted Average Mean of 4.47 which means "Very Good" in terms of the Design, 3.62 in terms of functionality which means the project is "Functional", 3.14 in terms of Durability which means the project is "Durable", and 3.15 which means the project is "Safe" in terms of Safety. The project received an overall workability score of 3.39, which indicates "Good" in terms of packaging technique, 3.11 in terms of marketability, which indicates "Marketable," and 4.37 in terms of portability, which indicates "Very Portable."

INTRODUCTION

Road side emergencies such as tire punch, is a problem commonly observed in cars. Jacks are devices for lifting loads that are utilized. Power screws are used in bearing the load. The efficiency is maximized with the use of lubrications. Furthermore, electrically operated car scissor jacks are powered by 12 volt electricity supplied directly from the car's cigarette lighter receptacle.These car jacks employ electrical energy to raise and lower themselves automatically; driving a car jack requires less effort than that of a manual jack.

Using mechanical advantage, conventional car jacks let a person to manually raise an automobile. The only method used by mechanical jacks to raise and lower their loads is physical. Using mechanical advantage, these jacks are commonly seen in the automotive industry for lifting vehicles and other loads. Meanwhile, a toggle jack is a machine which, when a small force is applied in its horizontal plane is used to raise or lower a large load. It is usually applicable in the automobile industry for raising a side of the vehicle during tire changing.

A toggle jack is a machine which, when a small force is applied in its horizontal plane is used to raise or lower a large load. It is usually applicable in the automobile industry for raising a side of the vehicle during tyre changing [1].

A common type of mechanical jack is known as a "screw jack or toggle jack." With the use of a motor, or a lever that is cranked by an operator, A screw raises or lowers the jack by adjusting the geometry of its threads. Depending on the type of jack, the screw itself may raise or lower the load, or a traveling nut does the raising while the screw turns in place.

A toggle jack, or screw jack or mechanical jack, is a type of jack that is operated by turning a leadscrew.It is frequently used as an adjustable support for big loads, to raise and lower an aircraft's horizontal stabilizers, and to lift somewhat heavy objects like cars, such as the foundations of houses.

It functions similarly to an inclined plane and is composed of a bolt and nut combination. when a nut moves axially in opposition to an opposing axial force while a thread coiled around a shaft rotates in its bearings.The goal of this project is to investigate and create a power-operated, time-saving, and more effective toggle jack. By making life easier for the end user, one of the goals of technology is achieved. Proper design considerations were made for this project, including the stresses, the bending moment of the shafts, the strength of the materials, and the maximum load it is expected to carry. Safety and dependability were therefore given top priority.

These jacks have many applications that include moving platforms on stages, changing settings on woodworking machinery, and adjustments of radio telescopes. Other applications also involve the use of mechanical jacks and they provide some advantage over hydraulic systems. Mechanical systems are normally self-locking. This means that when power is removed from the

jack, the screw remains in the same position until power is reapplied. These jacks are safer to use than hydraulic ones because of their self-locking features, which eliminate the possibility of power outages. One of the limitations of a mechanical system is its inability to lift loads to the same extent as hydraulic lifts. Levers that offer a mechanical advantage for manual tasks are also limited in length before they bend and lose their usefulness.

Toggle and screw jacks are examples of mechanical jacks that elevate loads using a power screw. The link members of the toggle jack are configured with some degree of flexibility. Meanwhile, the hydraulic jack does not require a screw; it runs on fluid. To lift the loaded shaft, this is accomplished by pumping or raising the fluid pressure in the cylinder.

OBJECTIVES OF THE STUDY

The following are the objectives of this study as follows:

1. To develop a mechanism in mechanical toggle jack lifter using AC/DC to be more efficient, stress free, saves time and a reliable way to achieve lifting of the load.
2. Evaluate the acceptability of the developed device in terms of *design and construction*, *functionality*, *durability*, *and safety*.
3. To determine the efficiency of the mechanical toggle jack lifter and manual jack in terms of:

a. Thread deformation test (*maximum displacement of jack*, *lifting time for electric jack* and *lifting time for manual jack*); and
b. Maximum load carrying test (*weight kg* and *displacement of jack mm*).

RESEARCH METHODOLOGY

The researcher used Project Development Method (PDM) and descriptive evaluative method to determine the general acceptability of the project. The data on the acceptability of the developed device in terms of *design and construction*, *functionality*, *durability and safety*. The data gathering instrument that will be used are sets of questionnaire checklist from the thirty selected respondents as automotive instructors, automotive students, mechanics, welders and shop owners.

Meanwhile, the efficiency of the project evaluated using Observation and Experimental Methods in terms of thread deformation test along the maximum displacement of jack and lifting speed of the AC/DC mechanical lifter in contrast with the lifting time for manual jack and maximum load carrying test along weight in kg and displacement in millimeter.

Meanwhile, the five-point Likert's rating scale used to determine the acceptability and descriptive meaning of the indicators of the variables used along *design and construction*, *functionality*, *durability and safety* of the device.

Meanwhile, WAM applied to interpret the equivalent meanings of the data gathered. Finally, the ANOVA will be applied to determine if there are significant differences in the responses and evaluations of the respondents in terms of its acceptability along the identified variables.

RESULTS AND DISCUSSION

In order to determine the general acceptability of the project in terms of *project design, durability, functionality,* and *safety and maintenance*, Tables below present the data of interest.

A. General Acceptability of the DC Powered Hydraulic Jack Lifter

Table 1 presents the general acceptability of the DC powered hydraulic jack lifter.

Table 1 General Acceptability of the DC Powered Hydraulic Jack Lifter along Project Design

Project Design	WAM	Qualitative Description
1. Automotive instructors	4.50	Very Good
2. Mechanics	4.47	Very Good
3. Automotive students	4.45	Very Good
Overall Weighted Average Mean	**4.47**	**Very Good**

Along project design that leads to the general acceptability of the DC hydraulic jack lifter, the automotive instructors gave a weighted average mean 4.50; 4.47 for the mechanics; and 4.45 for the automotive students. The computed OWAM is 4.47 and interpreted as "*very good*" This shows that the respondents have chosen the design of the DC hydraulic jack lifter. The design of the project is applicable for lifting activities. This indicates that the apparatus is *highly acceptable*.

Table 2 presents the general acceptability of the DC powered hydraulic jack lifter along of functionality.

Table 2 General Acceptability of the DC Powered Hydraulic Jack Lifter along Functionality

Functionality	WAM	Qualitative Description
1. Automotive instructors	3.60	Functional
2. Mechanics	3.64	Functional
3. Automotive students	3.64	Functional
Overall Weighted Average Mean	**3.62**	**Functional**

It can be seen in this Table that the automotive instructors gave a weighted average of 3.60; 3.64 for the mechanics; and 3.64 for the automotive students. Meanwhile, the computed OWAM is 3.62 equivalent to qualitative description of "*functional*". This shows that the DC powered hydraulic jack lifter is useful and *highly acceptable* for lifting works.

Table 3 presents the general acceptability of the DC powered hydraulic jack lifter in terms of durability.

Table 3 General Acceptability of the DC Powered Hydraulic Jack Lifter along Durability

Durability	**WAM**	**Qualitative Description**
1. Automotive instructors	3.17	Durable
2. Mechanics	3.15	Durable
3. Automotive students	3.11	Durable
Overall Weighted Average Mean	**3.14**	**Durable**

As seen in the Table, the automotive instructors gave weighted average mean of 3.17; mechanics 3.15 and 3.11 for the automotive students. The computed OWAM is 3.14 falls under the qualitative description of "*durable*". This shows that the construction of the hydraulic lifter is well done. Hence, the DC powered hydraulic jack lifter is properly constructed and assembled. The project is *efficiently acceptable* in all lifting works.

Table 4 presents the general acceptability of the DC powered hydraulic jack lifter along safety.

Table 4 General Acceptability of the DC Powered Hydraulic Jack Lifter along Safety

Safety	**WAM**	**Qualitative Description**
1. Automotive instructors	3.08	Safety
2. Mechanics	3.19	Safety
3. Automotive students	3.20	Safety
Overall Weighted Average Mean	**3.15**	**Safety**

As to safety in using the DC powered hydraulic jack lifter, the automotive instructors gave a weighted average mean of 3.08; meanwhile, 3.19 is given by the mechanics and 3.20; for the automotive students. As a whole, the computed OWAM of 3.15 is equivalent to a qualitative description of "*safety*". This shows that the lifter is safety to use. It is implied that the device is *highly acceptable*.

According to Seguban, (2010) when a project is safety to use it is presumed that it was assembled properly and highly acceptable. However, Juarez (2010) disclosed that the safety and security of a project depends on the manner of using it. It is very important to note in using a machine, one should follow the instructions properly to avoid accident or sudden damage.

B. Overall Workability of the DC Powered Hydraulic Jack Lifter in terms of *Packaging Technique, Marketability* and *Portability*

Furthermore, the Tables below presents the overall workability of the DC hydraulic jack lifter along durability, packaging technique, marketability and portability.

Furthermore, Table 5 presents the overall workability of the DC powered hydraulic jack lifter along packaging technique.

Table 5 Overall Workability of the DC Powered Hydraulic Jack Lifter in terms of Packaging Technique

Packaging Technique	**WAM**	**Qualitative Description**
1. Automotive instructors	3.48	Good
2. Mechanics	3.37	Good
3. Automotive students	3.34	Good
Overall Weighted Average Mean	**3.39**	**Good**

As to the overall workability of the multipurpose DC powered hydraulic jack in terms of packaging technic, the weighted average mean of the automotive instructors is 3.48; 3.37 for the mechanic; and 3.34 for the automotive students. The computed OWAM of 3.39 gave a qualitative description of "*good*". This goes to show that the DC powered hydraulic jack lifter is smartly done. The packaging technique applied is *highly workable*. This implies that the project is attractively done.

Santos (2014) disclosed that one of the factors to determine the quality of packaging of a project is the kind of materials used. Likewise, the polishing technique applied is an important factor that made the apparatus attractive. However, if there are poor quality materials used in the construction of the project it cannot be expected a worth package.

Table 6 presents the overall workability of the DC powered hydraulic jack lifter along marketability.

Table 6 Overall Workability of the DC Powered Hydraulic Jack Lifter in terms of Marketability

Marketability	WAM	Qualitative Description
1. Automotive instructors	3.12	Marketable
2. Mechanics	3.10	Marketable
3. Automotive students	3.13	Marketable
Overall Weighted Average Mean	**3.11**	**Marketable**

Along this area the automotive instructors gave a weighted average mean of 3.12; 3.10 for the mechanics and 3.13 for the automotive students. The computed OWAM is 3.11 described as "*marketable*". This shows that the DC powered hydraulic jack lifter is marketable due to its design. It could be implied that the project is really *workable* for lifting activities.

Furthermore, Table 7 gives the overall workability of the DC powered hydraulic jack lifter and charger along portability.

Table 7Overall Workability of the DC Powered Hydraulic Lifter in terms of Portability

Portability	WAM	Qualitative Description
1. Automotive instructors	4.39	Very Portable
2. Mechanics	4.38	Very Portable
3. Automotive students	4.37	Very Portable
Overall Weighted Average Mean	**4.38**	**Very Portable**

As seen in the Table, the automotive instructors gave a weighted average mean of 4.39; 4.38 for the mechanics; and 4.37 for the automotive students. As a whole, the computed OWAM is 4.38 indicated that the DC powered hydraulic jack lifter is "*very portable*". This means that the apparatus is *highly workable* because it is transferrable. It can be brought anywhere when it is needed.

However in some cases, the accessibility of a project depends on its size and design. If a project is lightweight then it is transportable. But if it is heavy and bulky it is movable. Anybody could not just transfer or drive the project anywhere to perform its functions (Seguban, 2011).

Summary of Findings Conclusions and Recommendations of the Study

The following were the significant findings of the study:

1. The project design is *good*. It is *functional*, *durable* and *safety*.
2. It is highly acceptable in all lifting works.
3. The *packaging technique* is good, the project is *marketable* and *portable*.
4. It is highly workable in lifting activities.
5. It is user friendly.

CONCLUSIONS

Based on the findings, the project design is *good*. It is *functional*, *durable* and *safety*. The DC powered hydraulic jack lifter is highly acceptable in all fields of lifting. Likewise, the packaging technique is good. The project is marketable and portable. It is workable. The apparatus is user-friendly for it is easy to use and maintain. The apparatus was constructed out of local materials which are available in the locality and cheaper. It is very minimal.

RECOMMENDATIONS

Based from the given conclusions, the following recommendations are hereby given:

1. The apparatus should be patented prior to its commercialization.
2. High quality of materials should be used for lighter, stronger and more durable overhauling table.
3. Minor revisions of the design should be done for better performance.
4. Further studies should be conducted to come up with other useful features of the project.

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